MENOUFIYA UNIVERSITY
FACULTY OF ENGINEERING
ELECTRICAL ENGINEERING DEPT.

POSTGRADUATE EXAMINATION
TOPIC: HVDC TRANSMISSION
DATE:18/ 1/ 2014
TIME ALLOWED: 3 HOURS

ANSWER THE FOLLOWING QUESTIONS:

1-a) **Discuss briefly the effect of the AC transmission problems and their influence on the DC transmission.**

1-b) Give a quantitave analysis to show how much are the transmitted power and percentage losses can change if an existing double circuit a.c. transmission system is converted to d.c. transmission either by using overhead transmission lines or cables on the basis of same current. Give this comparison again o n the basis of same percentage line losses.

2-a) Derive the regulation equations for the 3- phase converter bridge operating as a rectifier at constant firing angle α° and as an inverter operating at constant extinction angle γ°, give the equivalent circuit of the converter referred to the d.c. side for both cases.

2-b) Drive an expression for the active current drawn by the HVDC converter rectifier interms of the AC voltages, commutation reactance, the overlap and the firing angle. Deduce the similar expression for the active current drawn by the inverter.

3-a) show that the slope of the constant current control portion of the $v_d - i_d$ characteristic dV_d/dI_d can be given in terms of the commutation reactance and the control amplifier gain .

3-b) Describe two methods used for HVDC converter firing angle controls,

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4-a) Sketch the typical Vd – Id characteristic of the HVDC transmission controls, illustrating how the transition between mode A and mode B controls can occur.

4-b) Consider a single pole hvdc transmission, one converter of 150 kV rated voltage and 1800 A rated current. The inverter extinction angle γ is 18o and the rectifier firing angle α is 15°. The dc line resistance is 15Ω. Determine the ideal dc no-load voltage (Vo) at the rectifier, the rectifier dc voltage behind the commutation reactance, the inverter end line voltage and the inverter dc voltage behind commutating reactance. The rectifier transformer rating is 160 MVA, 88.95 kV with reactance 20% and the inverter transformer rating is 160 MVA, 83.55 kV with reactance 20%.

5-a) Describe briefly the harmonic instability and the triple cross over instability.

5-b) Derive a simplified equivalent circuit which can be used in the normal closed loop instability analysis of HVDC scheme. Deduce the value of the control amplifier gain in terms of the dc line parameters and converter commutation reactances which yields the stable operating conditions for the HVDC scheme.